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US 5138959 A US 5134946 A US 5010829 A

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(71) Applicant(s)
Industrial Technology Research Institute

(Incorporated in Taiwan)

No 195, Sec 4, Chung Hsing Road, Chutung Town, Hsinchu Hsien, Taiwan

(72) Inventor(s)
Kuo-Ching Chang
Shih Tsung Tseng
Jain-Sheng Huang

(74) Agent and/or Address for Service
Mewburn Ellis
York House, 23 Kingsway, LONDON, WC2B 6HP, United Kingdom

(54) Plasma waste disposal

(57) A waste processing means includes a high-temperature plasma heating means enclosed in a chamber having a waste transporting means for transporting the hazardous wastes to the plasma heating means for converting the hazardous wastes to a gaseous outflow and an induction heating plasma means for receiving a plasma gas and generating an induction heating plasma for further destructing and decomposing the gaseous outflow into a plurality of simple products suitable for final safe disposal.

FIG. 1

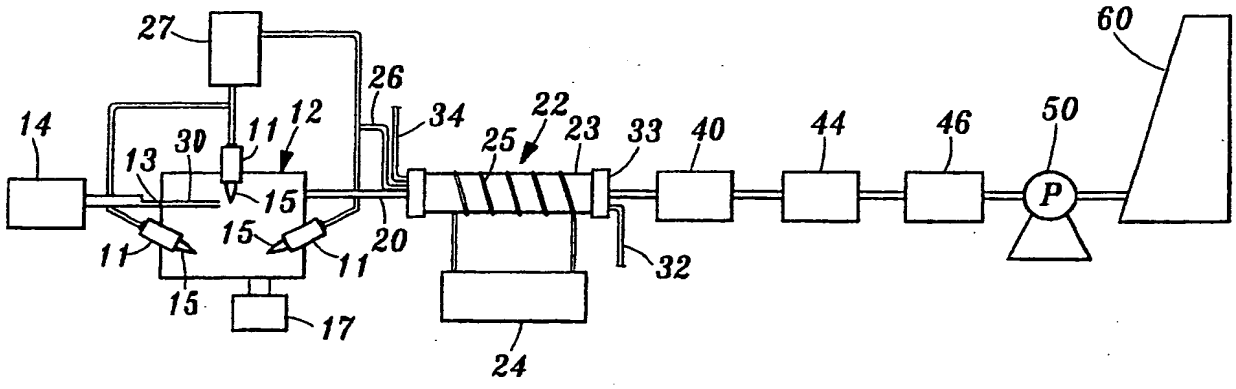

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FIG. 1

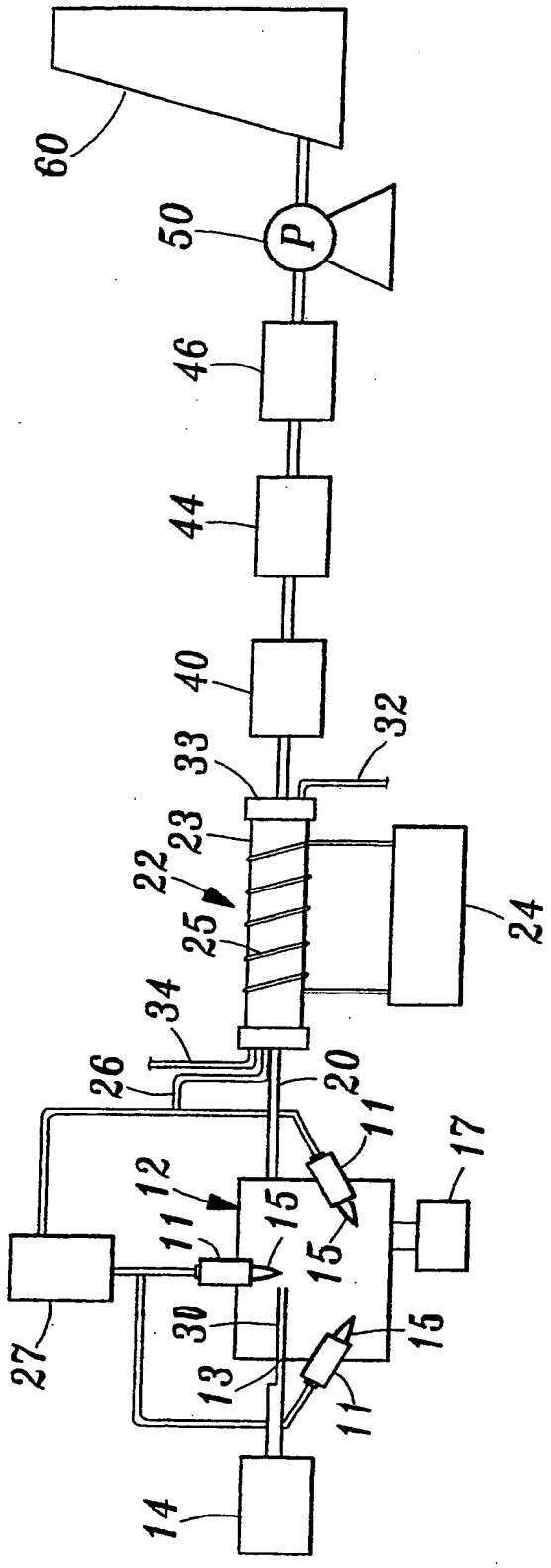
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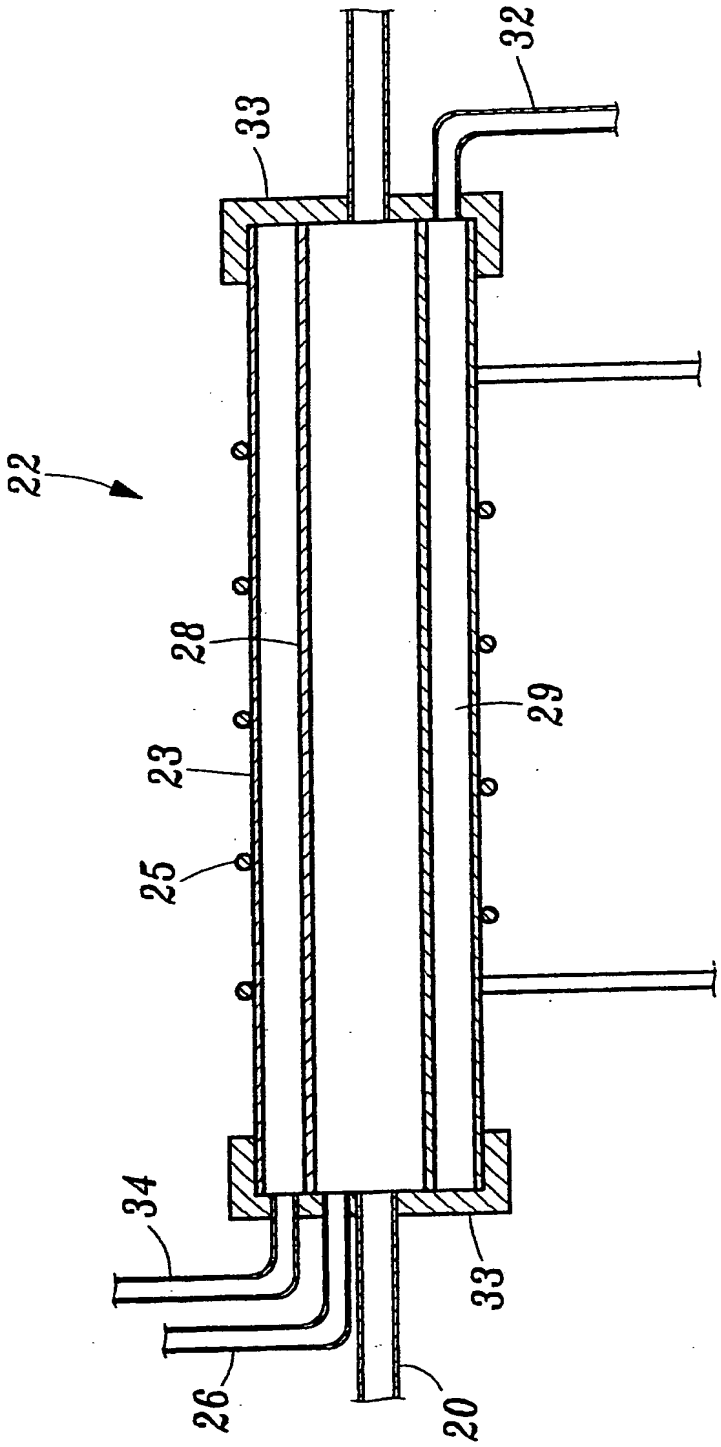
FIG. 2



SPECIFICATION

PLASMA WASTE DISPOSAL SYSTEM AND METHOD

This invention relates generally to a waste treatment system and method. More particularly, this invention relates to a combined waste treatment system and method wherein a plasma torch waste treatment apparatus is combined with an electric or magnetic induction heating plasma system to completely decompose highly hazardous wastes ready for further treatment before the final disposal of the hazardous wastes is performed.

One of the major concerns in the disposal of hazardous wastes, especially for highly toxic wastes, is the difficulty that there is no assurance that the wastes are completely decomposed whereby the final disposal of the wastes can be performed safely without causing residual harms to the environment. The need for safe disposal of the highly hazardous materials tends to increase with the advance of technology as growing number of toxic compounds are utilized in new processes for manufacturing more variety of products. Meanwhile, complete decomposition and safe disposal of these toxic wastes can not be easily accomplished, particularly, for the very stable highly toxic wastes such as

polychlorobenzene biphenyls (PCBs). If these highly toxic wastes are not decomposed completely, long term environmental damages may result if the residues of the toxic materials are released to the environment. Various techniques have been applied in attempt to dispose toxic wastes. These techniques include thermal destruction, chemical destruction, solidification for long term encapsulation, stabilization and special land fill methods. With the exception of high temperature incineration, these methods have demonstrated little success in safe disposal of highly toxic or extremely stable wastes such as PCBs. These methods are either very inflexible and inconvenient in requiring preprocessing the wastes into homogeneous waste feed stream or too limiting in processing only low toxic concentration. Additionally, very few of these methods are allowed to operate commercially because lack of reliable showing to the regulatory agencies that the final disposal by use of the method would be sufficiently safe in accordance with the governing rules and regulations for the final disposal of the hazardous wastes.

In applying the high temperature destruction method, particularly for the very stable organic toxic wastes, longer heat processing time at very high temperature is required. Very large scale furnaces or

rotary kilns to destroy the waste materials by the process of incineration are required. Such process thus uses large amount of oxygen and often produces through the combustion process by-products which may again present as much a disposal problem as the original toxic wastes.

More recently, the method of utilizing plasma arcs to pyrolytically destroy the toxic wastes are applied to overcome the problems encountered in the combustion techniques. The plasma arcs can atomize and ionize the toxic organic compounds into simple atoms and ions which are then recombined into simple products. Barton et al., disclose in U.S. Patent 4,644,877 entitled " Plasma Pyrolysis Waste Destruction " issued on February 24, 1987 a waste disposal method which uses a plasma arc to ionize and atomize the waste materials which are then recmbined and neutralized by an alkaline atomized spray. Gaseous products are burned before the final disposal. The system is quite complicated involving various heat treatments and chemical reactions and is therefore difficult to operate. Furthermore, for the very stable toxic wastes such as PCBs, the duration of the one stage heat treatment may not be sufficient. Final disposal of these processed wastes by the use of this method may still involve substantial long term environmental risk due to the likelihood that there may still be residual

toxic materials left after such processes because the concerns that the more stable may not be complete destroyed.

Therefore, for those skilled in the art, there is still a need for a new and improved waste treatment system and method. Specifically, the waste treatment system which is easy to operate and is capable of completely destroying the wastes to assure the final disposal of the materials is safe.

It is therefore an object of the present invention to provide a waste treatment system wherein complete decomposition of highly toxic wastes can be accomplished for final safe disposal without concerns of causing residual harmms.

Another object of the present invention is to provide a waste treatment system wherein high temperature heat treatment is used to completely decompose the highly toxic wastes without requiring oxygen whereby the undesirable by-products of polychlorinated dibenzo-p-dioxins (PCDD) is prevented from being generated in the waste disposal processes.

Another object of the present invention is to provide a waste treatment system to completely decompose

the highly toxic wastes wherein the waste treatment system does not require large volume and is therefore compact in size.

Another object of the present invention is to provide a waste treatment system utilizing plasma torch and induction heating plasma to completely decompose the wastes wherein the treatment system can be started just by turning on the power supply without requiring pre-heating or continuous operation.

Briefly, in a preferred embodiment, the present invention comprises a waste treatment system for decomposing hazardous wastes. The waste treatment system includes a first waste processing means for performing heat treatment of the hazardous wastes. The first waste processing means including a high-temperature plasma heating means enclosed in a chamber having a waste transporting means for converting the hazardous wastes to a gaseous outflow. The waste treatment system further includes a second waste processing means connecting to the first waste processing means for receiving the gaseous outflow. The second waste processing means includes an induction heating plasma means for generationg an induction heating plasma which is transferred into the gaseous outflow for further destructing and decomposing the

outflow into a plurality of simple products comprise molecules with basic forms of structure suitable for further treatments and then final safe disposal.

One advantage of the present invention is that it provides a waste treatment system wherein complete decomposition of highly toxic wastes can be accomplished for final safe disposal without concerns of causing residual harms.

Another advantage of the present invention is that it provides a waste treatment system wherein high temperature heat treatment is used to completely decompose the highly toxic wastes without requiring oxygen whereby the undesirable by- products of polychlorinated dibenzo-p-dioxins (PCDD) is prevented from being generated in the waste disposal processes.

Another advantage of the present invention is that it provides a waste treatment system to completely decompose the highly toxic wastes wherein the waste treatment system does not require large volume and is therefore compact in size.

Another advantage of the present invention is that it provides a waste treatment system utilizing plasma torch and induction heating plasma to completely

decompose the wastes wherein the treatment system can be started just by turning on the power supply without requiring pre-heating or continuous operation.

These and other objects and advantages of the present invention will no doubt become obvious to those of ordinary skill in the art after having read the following detailed description of the preferred embodiment which is illustrated in the various drawing figures.

Fig. 1 is a schematic diagram showing a waste treatment system of the present invention; and

Fig. 2 is a sectional view of a second waste processing means of the waste treatment system showing a waste disposal system utilizing the waste treatment system of Fig. 1.

Fig. 1 shows a waste treatment system according to the present invention. The waste treatment system comprises three plasma torches 11 with the high temperature torches 15 directed inwardly to the center of a plasma chamber 12. The plasma chamber 12 has an opening 13 to allow a transporting means 14 to transport the toxic wastes 30 into the plasma chamber 12. The transporting means 14 transports the toxic wastes near

plasma torch 11 directly under the high temperature torch 15. The wsates 30 which are transported by the transporting means 14 to the top plasma torch 11 are atomized and ionized to become liquid and gaseous products. The liquid pooducts flow down to the bottom of the plasma chamber 12 and are further heat processed by the plasma torches 11 near the bottom of the plasma chamber 12 wherein the decomposed products are collected in the collection container 17.

The plasma chamber 12 is an air tight chamber which is maintained at a low vacuum. This would prevent oxygen molecules to react with the atoms and ions generated from the decomposed wastes 30. The problem of forming the undesirable oxides, i.e., polychlorinated dibenzo-p-dioxins (PCDD), in the plasma chamber 12 is therefore eliminated.

Referring to Figs. 1 and 2, the gaseous products generated from the treatment of the wastes in the plasma chamber 12 are transferred through an outflow duct 20 to a second waste processing means which is an indution heating plasma means 22. The induction heating plasma means 22 includes an external chamber 23 which is surrounded by an induction coil 25 and an internal chamber 28 for receiving gaseous products generated from the heat treatment of the wastes. A cooling water duct

29 is defined by the external chamber 23 and the internal chamber 28, such that the cooling water coming from a watering tube 34 can enter into the water duct 29 for cooling use. The cooling water will further leave the system through a water outlet 32 after cooling. The plasma gas, which is generally argon or nitrogen, is provided to the internal chamber 28 by a plasma gas tube 26. The plasma gas tube 26 is connected to a plasma gas tank 27 which is either an argon tank or a nitrogen tank or both. The induction coil 25 is connected to a radiation frequency (RF) power supply 24 which provides an RF frequency current to the induction coils 25 thus generationg an electromagnetic field in the region of the external chamber 23 and the internal chamber 28. This electromagnetic field transfers energy to the argon atoms and converts them into plasma. The plasma-conversion process is induced first by reducing the pressure in the internal chamber 28 to five to ten torrs. The temperature of the argon gas in the internal chamber 28 is then increased by increasing the pressure to abort one atmosphere. At that pressure, an induction heating plasma is geneaterd because of collisions between the plasma particles.

The high temperature plasma contained in the plasma gas tube 26 is then introduced to the internal chamber 28. The energetic plasma particles including high speed

charged particles of electrons and helium collide with the bigger molecules in the outflow gas. The bigger molecules not yet completely decomposed contained in the outflow gas are further decomposed into simple molecules such as H_2, N_2, CH_4, etc., because the collisions among particles and the breakdown of the chemical bonds under the high temperature. This induction heating plasma treatment takes the advanantage of the fact that the outflow gas from the plasma chamber 20 contains atomized and ionized particles which makes the plasma-conversion process more efficient. Complete decomposition of the outflow gas is therefore accomplished by the use of this two-stage waste treatment system utilizing the plasma torches 11 and the induction beating plasma means 22.

Fig. 1 is a system diagram showing a complete waste treatment system wherein the wastes 30 after being treated by the plasma torch 11 in the plasma chamber 12 which is a chamber of approximately one meter by one and half meters rectangular enclosure. The outflow gas flow through the outflow duct 20 of about half meter to enter into an induction heating plasma chamber 22 which is a chamber of approximately eighty centimeters long by fifty centimeters square of width and depth. The induction heating plasma chamber has two insulation section 33 of approximately ten centimeters at both

ends. The induction plasms chamber 22 is surrounded by an induction coil 25. After the outflow gas from the plasma chamber 12 is further decomposed in the induction heating plasma chamber 22, the outflow gas is processed to become atoms or basic molecules. These atoms or molecules are received into a cooling chamber 40 wherein the twice-processed simple products comprise molecules of basic forms are cooled and further filtered to remove the particles in a filter chamber 44 and processed by an acid removing reactor 46 for removing the acids and then pumped by a vacuum pump 50 to be released through a release stack 60.

Although the present invention has been described in terms of the presently preferred embodiment, it is to be understood that such disclosure is not to be interpreted as limiting. Various alternations and modifications will no doubt become apparent to those skilled in the art after readingg the above disclosure. Accordingly, it is intended that the appended claims be interpreted as covering all alternations and modifications as fall within the true spirit and scope of the invention.

CLAIMS

1. A waste treatment system for decomposing hazardous wastes comprising:

a first waste processing means for performing heat treatment of said hazardous wastes including a high-temperature plasma heating means enclosed in a chamber having a waste transporting means for transporting said hazardous wastes to said plasma heating means for converting said hazardous wastes to a liquid residue and a gaseous outflow; and

a second waste processing means connecting to said first waste processing means for receiving said gaseous outflow, said second waste processing means including an induction heating plasma means for generating an induction plasma for further destructing and decomposing said gaseous outflow into a plurality of simple products suitable for final safe disposal.

2. The waste treatment system of claim 1 wherein:

said plasma heating means in said first waste processing means is a plasma torch for heating and decomposing said hazardous wastes.

3. The waste treatment system of claim 2 wherein:

said chamber for enclosing said plasma heating means is an air tight low vacuum chamber whereby said hazardous wastes are decomposed in the absence of oxygen.

4. The waste treatment system of claim 3 wherein:

said induction heating plasma means includes an internal chamber for receiving a plasma gas therein,said induction heating plasma means further includes an induction coil winding around an external chamber which surrounds the internal chamber, said induction heating plasma means further includes an RF power supply providing power to said induction coil for converting said plasma gas into induction heating plasma.

5. The waste treatment system of claim 4 further comprises:

a cooling and final processing means for cooling and removing a plurality of particles and acid materials from said processed wastes from said second waste processing means; and

a pumping means for maintaining said waste treatment system at a pre-determined pressure and for pumping said wastes processed by said cooling and final processing means to a final release or storge means to

final release or store said processed wastes.

6. A waste treatment system for decomposing hazardous wastes comprising:

a first waste processing means for performing heat treatment of said hazardous wastes including a high-temperature plasma heating means enclosed in a chamber having a waste transporting means for transporting said hazardous wastes to said plasma heating means for converting said hazardous wastes to a liquid residue and a gaseous outflow wherein said plasma heating means being a plasma torch for heating and decomposing said hazardous wastes;

said chamber for enclosing said plasma heating means being an air tight low vacuum chamber whereby said hazardous wastes are decomposed in the absence of oxygen, said low vacuum chamber further including an outflow duct for transporting said gaseous outflow out of said chamber;

a second waste processing means connecting to said first waste processing means for receiving said gaseous outflow, said second waste processing means including an induction heating plasma means for generating an induction plasma in said gaseous outflow for further

destructing and decomposing said outflow into a plurality of simple products suitable for final safe dispossal;

said induction heating plasma means includes an internal chamber for receiving a plasma gas therein,said induction heating means further includes an induction coil winding around an external chamber which surrounds the internal chamber, said induction heating plasma means further includes an RF power supply providing power to said induction coil for converting said plasma gas into induction heating plasma; and

a pumping means for maintaining said waste treatment system at a pre-determined pressure and for pumping said wastes processed by said cooling and final processing means to a final release or storage means to final release or store said wastes.

7. A waste treatment system for decomposing hazardous wastes substantially as herein described with reference to and as illustrated in the accompanying drawings.

8. A method for decomposing and disposing hazardous wastes comprising the steps of:

(a) transporting said wastes to a chamber

containing a high temperature plasma heating means;

(b) performing heat treatment of said hazardous wastes utilizing said high-temperature plasma heating means for converting said hazardous wastes to a gaseous outflow; and

(c) receiving said gaseous outflow and generating an induction plasma for further destructing and decomposing said outflow into a plurality of simple products suitable for final safe disposal.

9. The method for decomposing and disposal of wastes of claim 8 wherein said step (b) further comprises a step of:

(b1) utilizing a plasma torch for said plasma heatiing means for heating and decomposing said hazardous wastes.

10. The method for decomposing and disposal of wastes of claim 9 wherein said step (b1) further comprises a step of:

(b2) performing said heat treatment of said wastes in said chamber under a low vacuum whereby said hazardous wastes are decomposed in the absence of oxygen.

11. The method for decomposing and disposal of wastes of claim 10 wherein

said step (b2) further comprises a step of (b3) of transporting said gaseous outflow out of said chamber to an internal chamber; and

said step (c) further comprises a step (c1) of providing an RF power from an RF power supply to an induction coil winding around an external chamber which surrounds the internal chamber and receiving a plasma gas in said internal chamber for generating an induction heating plasma therein for further destructing and decomopsing said gaseous outflow.

Patents Act 1977
Examiner's report to the Comptroller under Section 17 (The Search Report)

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Application number
GB 9313334.6

Relevant Technical fields

(i) UK Cl (Edition L) F4B (BKF) (SE(EAD))

(ii) Int Cl (Edition 5) F23G 7/00 7/12 7/14

Search Examiner
ALEXANDER G SMITH

Databases (see over)

(i) UK Patent Office

(ii) ONLINE DATABASES: WPI

Date of Search
19 AUGUST 1993

Documents considered relevant following a search in respect of claims 1-11

Category (see over)	Identity of document and relevant passages		Relevant to claim(s)
Y	GB 222600 A	(VEB CHEME)	1,8
Y	GB 2152949 A	(PYROLYSIS SYSTEMS)	1,8
Y	GB 2136939 A	(SKF) note multiple plasma burners 7	1,8
Y	US 5138959	(KULKARNI) See second reactor 60 in Figure 3	1,2,8
Y	US 5134946	(POOVEY) See lines 27 to 30 in column 2 and the specific description of the torch	1,2,8
Y	US 5010829	(KULKARNI) See second reactor 60 in Figure 3	1,2,8

Category	Identity of document and relevant passages	Relevant to clai
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Categories of documents

X: Document indicating lack of novelty or of inventive step.

Y: Document indicating lack of inventive step if combined with one or more other d cuments of the same category.

A: Document indicating technological background and/or state of the art.

P: Document published on or after the declared priority date but before the filing date of the present application.

E: Patent docum nt published on or after, but with priority date earlier than, the filing date of the present applicati n.

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